QoS Modeling and Analysis using QML in Mobile Computing Environment

A Synopsis

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Introduction:

In today's environment, the need, uses and applications of the mobile networks are increasing. Most of the data communications depend on these emerging technologies. Mobile computing systems have non-functional properties that differ from fixed distributed systems due to the radio and mobile terminal characteristics. The term mobile computing system is used when considering a system consists of: application, middleware, operating system (OS), mobile terminal, and mobile communication system. End-to-end quality of service (QoS) in mobile computing systems is therefore the combination of QoS characteristics and QoS mechanisms across the system (Chalmers & Sloman, 1999).

Reliable message transfer with error control and notification of non-delivery is common in many modern communication systems. However, it is only recently that much thought has been given to the ability to specify timeliness, and the perceived quality of the data arriving, particularly where more complex (multi-) media are being used. The underlying concepts of bandwidth, throughput, timeliness (including jitter), reliability, perceived quality and cost are the foundations of what is known as Quality of Service (QoS).

In designing the applications over mobile networks, one must focus on quality of service (QoS). It is often required where a fixed bit rate is provided and the application are delay sensitive, and in those networks where the capacity is a limited resource, for example in mobile data communication. Quality of service is the ability to provide different priority to different applications, users, or data flows, or to guarantee a certain level of performance to a data flow (Chalmers & Sloman, 1999; http://en.wikipedia.org/wiki/Quality_of_service; Svend & Jari, 1998).

QoS Provides the Following Benefits:

- Gives administrators control over network resources and allows them to manage the network from a business, rather than a technical, perspective.
- Ensures that time-sensitive and mission-critical applications have the resources they require, while allowing other applications access to the network.
- Improves user experience.

- Reduces costs by using existing resources efficiently, thereby delaying or reducing the need for expansion or upgrades.

Modeling is a necessary activity while designing a system or application. It aims to express the essentials of some aspect of the system being designed, without unnecessary detail. It is often represented by visually by one or more diagrams (http://technet.microsoft.com/en-us/library/cc757120%28WS.10%29.aspx). QoS requirements are identified already at design-time. For modeling a system, we need adequate modeling languages. There are many modeling languages according to the area of applications. For modeling the QoS of any system, a specialized QoS Modeling Language (QML) has also been developed. Therefore, the QML can be applied to specify QoS properties like reliability and performance (Svend & Jari, 1998).

Background:

Overview of Quality of Service:

Many multimedia and real-time applications entail the concept of QoS, where there may be a scale of performance which is acceptable, and the boundary between success and failure of the system may be blurred or varying [BLAIR 97b]. For instance, a video may still be acceptable if presented with a lower frame rate, or reduced resolution, but be unacceptable for viewing if there are pauses or gaps in the film. The results of a search on data potentially returning many fields may still be acceptable if only the first few results are given initially, as long as this is done within a time limit, when appearance of efficiency is needed in front of customers, or where connection time waiting for results incurs cost. Management of QoS includes various aspects, relating to the nature of perceived quality. This section provides an overview of these, and the treatment they have been given in the literature. The topics covered are: i) Definitions Fundamental to QoS management; ii) Techniques for the static management of QoS; iii) Techniques for the dynamic management of QoS; iv) QoS issues relating to multiple stream systems, common in multimedia applications; v) QoS issues relating to managing faults and availability; vi) A brief overview of the work described in the literature relating to formal specifications, standards and practical investigations where the previously described techniques are applied.

Definitions and Categories of QoS:

The ISO/IEC recommendation X.901-5, Open Distributed Processing Reference Model (RMODP) provides a de-jure definition of QoS. This subsection presents an overview of the most critical parts of what QoS is, and what it entails, based on [BLAIR 97b, HUTCHISON 94,STOREY 96], whose treatment is primarily concerned with multimedia.

QoS Characteristics:

While systems are often defined in terms of their functionality, QoS defines non-functional characteristics of a system, affecting the perceived quality of the results. In multimedia this might include picture quality, or speed of response, as opposed to the fact that a picture was produced, or a response to stimuli occurred. Table 1 shows the main technology-based QoS parameters which we consider.

QoS is an internetworking issue that can be defined informally as something a system seeks to attain (Behrouz, 2007). The goal of QoS is to provide guarantees on the ability of a network to deliver predictable results. Elements of network performance within the scope of QoS often include availability (uptime), bandwidth (throughput), latency (delay), and error rate.

QoS Parameters:

There are several QoS parameters, but the following QoS parameters will be followed in this research (Behrouz, 2007; Chalmers & Sloman, 1999; Andrew, 2003)

Table 1: QoS Parameters

Category	Parameters	Description/Example
Timeliness	Delay	Time taken for a message to be transmitted.
	Response time	Round trip time from request transmission to reply receipt
	Jitter	Variation in delay or response time
Reliability	Mean Time To Failure (MTTF)	Normal operation time between failures. See [STOREY 96] for a further treatment of reliability issues.

	Mean Time To Repair (MTTR)	Down time from failure to restarting normal operation
	Mean Time Between Failure (MTBF)	MTBF = MTTF + MTTR
	Percentage of time available	MTTF/MTTF+MTTR
	Loss or corruption rate	Proportion of total data which does not arrive as sent, e.g. network error rate

QoS Specification:

An application's QoS requirements are conveyed in terms of high-level parameters that specify what the user requires (Andrew, 2003). QoS specification is different at each system layer and is used to configure QoS mechanisms at each layer. Possible system layers are (Svend & Zari, 1998):

- protocols - transport, network
- network layer
- middleware layer
- operating system - scheduling, resource management, real-time support
- distributed platforms - CPU, memory/buffers, devices
- application layer.

QoS in Mobile Computing System:

There has been much recent research on the provision of Quality of Service (QoS) guarantees in mobile computing environment. The critical design issues for mobile system include Quality-of-Service (QoS) guarantees, high service accessibility, reliable data transfer, and high communication performance (Chalmers & Sloman, 1999; Hansen, 1996). These all parameters affected by mobility, both during and between connections.

One of the aims of QoS is to manage the service response provided to low-speed devices such as mobile wireless devices. The QoS can be ensured only when the achieved / actual performance is greater than or equal to the desired performance (Samad and Herman, 2005; Srivastava & Mishra, 1997; Yung and Chen, 2001).

QML:

To facilitate QoS specification, a general Quality of Service Modeling Language has been introduced for defining multi-category QoS. QML is designed to support QoS in general QoS category such as reliability, performance, security, and timing (Miguel & Miguel, 2003). QML has been developed at HP Software Technology Laboratory (Amundsen et al., 2006; Steffen, 2008). QML is similar to interface definition language that describes the functional prosperities of software component. It also allows specification at a fine-grained level for operations, operation arguments, and attributes. QML is designed for a good fit with object-oriented distribution architecture (Svend & Jari, 1998).

Basic Requirements:

The main design consideration for QML is to support QoS specification in mobile computing system. We want QML to integrate seamlessly with existing mobile computing system. This overall goal results in the following specific design requirements for QML (Svend & Jari, 1998).

- QoS specifications should be syntactically separate from other parts of service specifications, such as interface definitions. This separation allows us to specify different QoS properties for different implementations of the same interface.
- It should be possible to specify both the QoS properties that clients require and the QoS properties that services provide. Moreover, these two aspects should be specified separately so that a client-server relationship has two QoS specifications.
- There should be a way to determine whether the QoS specification for a service satisfies the QoS requirement of a client. This requirement is a consequence of the separate specification of the QoS properties that clients require and the QoS properties that services provide.
- QML should support refinement of QoS specifications.
- It should be possible to specify QoS properties at a fine-grained level.

Review of Literature:

Sten et al. (2006) presents a general QoS framework with QoS specific elements for mobile middleware, which combines and extends existing QoS frameworks. Steffen (2008) presented the Quality of Service Modeling Language (QML), a language which can be used to describe QoS offerings or needs of specified services.QML has been developed at HP Software Laboratory.

Chalmers & Sloman (1999) presented the specification and management of Quality of Service (QoS) is important in networks and distributed computing systems, particularly to support multimedia applications. This paper is a survey of QoS concepts and techniques for mobile distributed computing environments.

Svend & Jari (1998) presented a general Quality of service Modeling Language (QML) for defining multi-category QoS specifications for components in distributed object systems. QML is designed to support QoS in general, encompassing QoS categories such as reliability, performance, security, and timing.

Svend & Jari (1998) proposed a general Quality-of-Service specification language, which we call QML. In this paper we show how QML can be used to capture QoS properties as part of designs. In addition, we extend UML, the de-facto standard object-oriented modeling language, to support the concepts of QML.

Garcia (2006) presented the arrival of fourth generation mobile networks, based on IP core networks, lead us to the development of certain services, such as: Quality of service, mobility and AAA. This paper proposes architecture to supply quality of service support based in the differentiated services technique.

De Miguel (2003) presented QoS-aware models support the description of software architectures with quality requirements are part of an initial submission of OMG RFP “UML Profile for Quality of Service and Fault Tolerance Characteristics and Mechanisms”.

Samad and Herman (2005) present a study of the quality of service (QoS) performance over the mobile IP in wireless network. This mobile IP models are developed using the OPNET modeler 10.0, a hierarchical software programming and it is utilised to analyze the performance of two metrics for QoS; throughput and packet data dropped during forwarding and receiving data packets operation. The results achieved are based on the comparison of two scenarios of mobile IP model in a wireless network.

Srivastava & Mishra (1997) describes the necessary support required in various layers of mobile wireless networks, and advocates specific solutions based on empirical validations. This addresses the choices that need to be made in the design of a quality of service (QoS) framework for mobile and wireless networks. Yang & Chen (2001) presented Adaptive multimedia is promising in wireless/mobile networks since it mitigates the fluctuation of resources caused by the mobility in wireless/mobile networks.

Justification/Importance of Study:

Network designing techniques are very complex. The QML can help reducing the network design complexity. QML is widely used modeling language in development processes. However, QML is well adapted for the specification non-functional aspect such as QoS.

Importance of this study is that how to model and analyze the parameters of QoS of mobile computing environment using QML. The contribution will be to add to QML the ability to specify and handle the QoS that will be used in the mobile computing environment. Therefore the design of mobile computing environment will be done using QML language. The analysis and measurements of the QoS parameters using tools (eg. NS-2) will be done, and then a comparison between the Design time QoS parameters to Actual parameters will be performed. I will also find out the differences and causes of modeling and give some suggestions to improvement and extension in QML.

Research Objectives and Problems:

The overall aim of this research is to do modeling the QoS in mobile computing environment using modeling languages QML and analyzing QoS parameters using of tools. The overall goal is to find the suitability of appropriate modeling language for specifying and analyzing the parameters of QoS in mobile computing environment.

The following problems will be solved in this work:

1. Modeling the QoS parameters using QML for Mobile Computing Environment.
2. Analyzing the QoS Parameters (Timeliness and Reliability) using Tool for Mobile Computing System.
3. Practically measuring these Parameters for evaluating purpose and verification of design.

Methodology:

In the proposed work, the research emphasis on the:

- Literature Survey: In depth analysis of existing work and their results.
- Case Study: Modeling of QoS using QML in mobile computing environment. Two case studies will be taken for similar applications.
- For Experimental Purpose a tool will be used.

For modeling, appropriate tools will be used. For analyzing the QoS parameters, a Simulator Tool (eg.NS2, Met lab, Java) will be used. The Data will be analyzed and the results will be presented.

Place of Work and Facilities Available:

The Place of Work will be Jayoti Vidyapeeth Women University Campus.

The following facilities will be used:

- IEEE Login Provided by the University
- Server System will help to implement the wireless and mobile network
- Campus Library
- Software tool (eg.NS2)

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